REMARKS

This Application has been carefully reviewed in light of the Non-Final Office Action mailed October 21, 2003. At the time of the Office Action, Claims 1-10, 12-21 and 23 were pending in this Application. Claims 1-10, 12-21 and 23 were rejected. Claims 1, 3, 12, 15-16 and 23 have been amended. Claims 24 and 25 have been added. Applicants respectfully request reconsideration and favorable action in this case.

Rejections under 35 U.S.C. § 103(a)

Claims 1-7, 12-18 and 23 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Akiyama et al. (U.S. Patent 5,977,940) (hereinafter "Akiyama"), further in view of Nakao (U.S. Patent 6,437,716) (hereinafter "Nakao"). Applicants respectfully traverse the rejections and submit that the references relied upon do not teach or suggest, individually or in combination, what is claimed in independent claims 1 and 12.

The present invention relies upon only two optical states of the liquid crystal material, an optically "on" and an optically "off" state. This could mean that light is reflected (white) in one state and not reflected (black) in the other. It could also mean that light passes through (transmissive) the LCD in one optical state and does not pass through in the other optical state. It also could mean that light is generated in one optical state and not generated in the other state. Operation of the invention is binary for its optical properties, meaning that the LCD or MEM (tiny mirrors) either produce light (reflective, transmissive, source, *etc.*) or do not. The invention maintains the optical state of a pixel for a controlled length of time before changing to the other optical state. Varying the amount of time that a pixel is in a certain optical state

determines the intensity or brightness of that pixel. An advantage of the invention is that variations of the EO (electro-optic) curve of the LCD is not critical to operation thereof. Since the LC (liquid crystal) of the LCD may be driven to either optical state with a wide margin, the construction, temperature, material uniformity, etc., of the LCD is not so critical as in the analog variation of the EO curve of prior art LCDs.

In the references relied upon, the pixel light intensity is determined by an analog voltage value varying over the EO (electro-optic) curve of the LCD. Time is not a factor in generating the light intensity from the pixels of the LCD. Akiyama teaches varying a pulse width to generate a certain voltage for a pixel:

> Since the liquid crystal generally operates corresponding to the effective value of the voltage V_{LC}, by varying the pulse width Tw of the voltage V_{LC} , the effective voltage supplied to the liquid crystal layer 5 is controlled. Thus, the optical response (transmissivity of light and reflection rate) is varied and a picture is displayed. Of course, since the average value of the voltage V_{LC} is also controlled, the optical response of the liquid display can be controlled corresponding to the average value of the voltage V_{LC}.

Column 11, lines 42-50 of Akiyama. Nakao teaches using an analog voltage having a plurality different values corresponding to an EO curve of an LCD. *See* Figure 12 of Nakao.

Rather than following the prior art method of applying an analog voltage to drive the Liquid Crystal (LC) to various points on the EO curve to produce shades of color, in the present invention the voltage (at each pixel) is compared to a reference voltage input to the LC to control the duration that the LC is "optically on", such as in a similar manner as set forth above in the section entitled "Digitally Controlled Waveform Method" of the instant application. For each frame (or field when using field sequential color), all pixels in the matrix are allowed to become optically on (or off) prior to the application of illumination. When illumination is

applied, the reference voltage is changed over time, causing each pixel to change state (optically on to off, or off to on) at the precise time that its voltage value matches the reference level.

See, Figure 25A of the instant application, depicted is a diagram of a circuit 2500 associated with one pixel according to an embodiment of the present invention. As shown, a multiplexer 2501 receives a reference input signal (that represents the reference voltage) and a data input (that will be stored in the capacitor as set forth below). A Digital to Analog (D/A) converter 2502 converts the digital data input signal from the multiplexer to an analog pixel voltage that that is stored in a capacitor 2504. This is the voltage that will be compared to the reference voltage.

The D/A converter generates an analog reference voltage from a digital reference input signal. A comparator 2506 compares the reference voltage to the stored pixel voltage. Upon the reference voltage crossing over the pixel voltage, the comparator indicates such event, such as by switching from high to low, for example. A select switch 2508 is used to send the input reference voltage to the comparator.

A pixel latch 2510 receives input from the comparator. If the comparator input indicates that there was a match, the pixel latch will switch to turn the pixel to the opposite state. If the comparator input indicates that there was not a match, the pixel latch will remain unchanged, as will the pixel state. A level shifter 2512 changes the voltage to a higher voltage, such as where the output voltage to the pixel electrode is higher than the operating voltage for other portions of the circuit, for example. The higher or lower voltage from the level shifter is sent to a pixel electrode 2514 to change the state of the pixel.

For field sequential color, the analog levels of RGB can be individually selected

(multiplexed) over time for presentation to the analog comparator. The output of the comparator controls the state of a single pixel, which is illuminated with the appropriate color in the field sequence.

Since the output of such an arrangement is essentially digital, local pixel inversion can be applied in concert with ITO inversion to allow for the benefits of AC driving of the LC.

The described circuit and method can be applied as an improvement to all existing implementations of analog active matrix LC panels and cells. The described circuit may be equally applicable as an improvement to non-active matrix implementations of analog LC panels and cells as well as to MEMS displays and other types of displays.

The described circuit may have direct application to control color levels in OLED displays. In this case, OLEDs may be driven digitally in their optimum illumination range, resulting in potential power savings and simplified color level control. Additionally, by separating pixel groups into multiple phased cycles, power consumption can be spread evenly over time. These grouped pixels may, of course, be physically interspersed on the display to avoid flicker a low update rates.

Figure 25B is a flow diagram of a process 2550 for driving a display. In operation 2552, a voltage value is stored in an analog memory associated with each pixel of a display, where each of the pixels also has a comparator associated with it. Note that there may be single memory cells for each pixel. A reference voltage and the voltage values stored in the analog memory are applied to the comparators of the pixels in operation 2554. In operation 2556, the comparators are used to compare the voltage values with the reference voltage for determining which of the voltage values matches the reference voltage. The state of the pixels whose voltage

values match the reference voltage is changed in operation 2558.

Again, the display can be an active matrix panel display as well as a non-active matrix display, OLED display, or other type of display. As an option, illumination may be applied after the actuation of the one or more pixels. The reference voltage can be changed as a function of time to cause each pixel to actuate and de-actuate at a desired time. Groups of the pixels can be actuated. In such case, the groups of pixels are actuated in multiple phased cycles. Preferably, the groups are interspersed on the display to avoid flicker at low update rates.

The human eye does not perceive light intensity in a linear fashion. If a light source is emitting twice the number of photons as another, it appears brighter to the human eye, but is not perceived as "twice as bright". Human perception of light intensity follows a logarithmic curve. Therefore, to faithfully reproduce an image, gamma correction may be required.

Because each pixel can be made to change state after a particular period of time has elapsed, the gamma of each pixel can be precisely controlled. By changing the waveform for a particular pixel (to change the period of time that the pixel is on or off), the level of gray can be adjusted for each pixel to provide gamma correction.

None of the references relied upon teach or suggest, individually or in combination, changing the optical state of each of the pixels when the respective voltage values match the reference voltage values, as recited in independent claims 1 and 12.

Claims 2-7 depend from claim 1, and claims 12-18 and 23 depend from claim 12 and contain all limitations thereof.

Claims 8-10 and 19-21 were rejected under 35 U.S.C. § 103(a) as being

unpatentable over Akiyama as applied to Claims 1 and 12 above, and further in view of U.S. Patent 5,965,907 issued to Huang et al. (hereafter "Huang"). Applicants respectfully traverse the rejections and submit that the references relied upon do not teach or suggest, individually or in combination, what is claimed in independent claims 1 and 12 as amended.

Huang teaches construction of an OLED, but does not teach or suggest changing the optical state of pixels as a function of time, as discussed above. The references relied upon do not teach or suggest, individually or in combination, changing the optical state of each of the pixels when the respective voltage values match the reference voltage values, as recited in independent claims 1 and 12.

Claims 8-10 depend from Claim 1 and contain all limitations thereof.

Claims 19-21 depend from Claim 12 and contain all limitations thereof.

All amendments are made in a good faith effort to advance the prosecution on the merits. Applicant reserves the right to subsequently take up prosecution on the claims as originally filed in this or appropriate continuation, continuation-in-part and/or divisional applications.

Applicants respectfully request that the amendments submitted herein be entered, and further requests reconsideration in light of the amendments and remarks contained herein.

Applicants respectfully request withdrawal of all objections and rejections, and further respectfully request that there be an early notice of allowance.

SUMMARY

In light of the above amendments and remarks, Applicants respectfully submit that the application is now in condition for allowance and early notice of the same is earnestly solicited. Should the Examiner have any questions, comments or suggestions in furtherance of the prosecution of this application, the Examiner is invited to contact the attorney of record by telephone, facsimile or electronic mail, as below.

Applicants submit herewith a Petition for Two-Month Extension of Time, and check #879006 in the extension of time fee amount of $210.00 at the small entity rate. Applicants believe that there are no additional fees due in association with the filing of this Response. However, should the Commissioner deem that any additional fees are due, including any additional fees for extensions of time, Applicants respectfully request that the Commissioner accept this as a Petition Therefor, and further direct that any and all additional fees due are charged to, or any overpayments are credited to, Baker Botts L.L.P. **Deposit Account No. 02-0383, Order Number 075115.0176**.

Respectfully submitted,

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